CHAPTER 3

HYDRAULIC SEALS

TYPES

Seals reduce or prevent internal and external leakage between two objects. Hydraulic seals are used throughout aircraft hydraulic systems to cut down on internal and external leakage of hydraulic fluid, thereby preventing loss of system pressure. Two general types of seals used in hydraulic and pneumatic systems are the dynamic type and the static type. A dynamic seal is used between two moving parts of a unit. A static seal is used between two stationary parts.

IDENTIFICATION

Seals are classified according to their shapes. (See Figure 3-1.) Notice that the O-ring is circular in shape, the T-ring looks like an upside down T, the D-ring looks like a D, and the V-ring looks like a V.

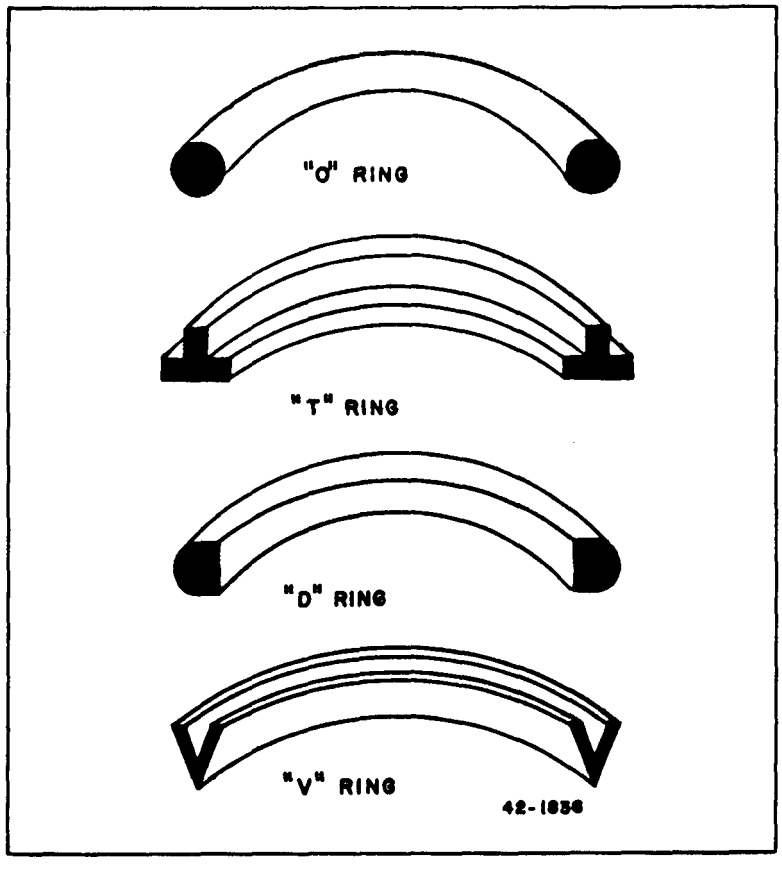


Figure 3-1. Hydraulic seals.

Most of the dynamic and static seals used on today's aircraft are manufactured in the form of O-rings and are called packings. However, conditions will arise when special nonstandard seals will have to be made for specific uses on the aircraft. (See Figure 3-2.)

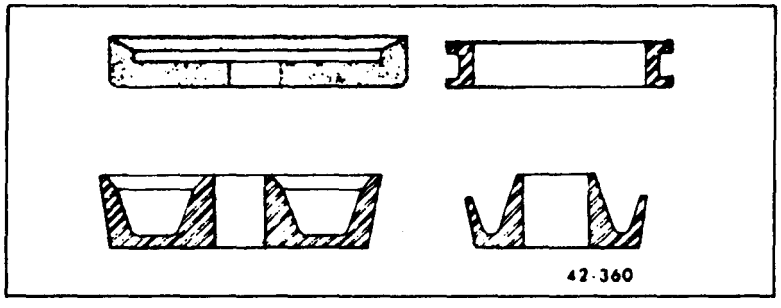


Figure 3-2. Nonstandard seals.

A hydraulic seal may consist of more than one component, such as an O-ring and a backup ring or possibly an O-ring and two backup rings. Hydraulic seals between nonmoving fittings are called gaskets; hydraulic seals inside a sliding or moving part are called packings. Most gaskets and packings used in Army aircraft are manufactured in the form of O-rings (Figure 3-3), but elliptical seals are used in some landing gear struts. (See Figure 3-4.)

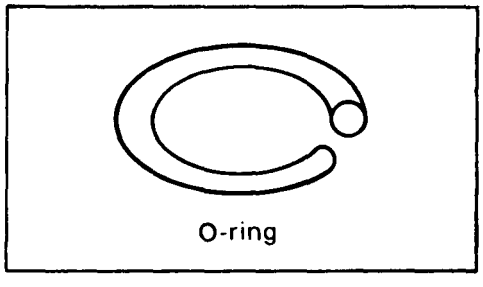


Figure 3-3. O-ring seals.

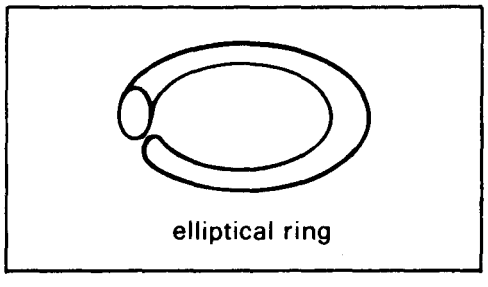


Figure 3-4. Elliptical seals.

COMPOSITION

Seals are composed of several different types of materials. The material depends on the use of the seal and the type of fluid it will come in contact with. The seals used in petroleum-base hydraulic fluid (MIL-H-5606) are made from synthetic rubber (nitrile). Seals in Skydrol 500 fluid systems are made from ethylene-propylene. Since our current aircraft use synthetic-base fluid MIL-H-83282 with limited amounts of petroleum-base fluid MIL-H-5606, only the seals associated with these fluids will be discussed.

Advances in aircraft design make it necessary to develop O-ring seals out of compounds that could meet the changing conditions. Hydraulic O-rings were originally established under AN (Air Force-Navy) specification numbers (6227, 6230, and 6290) for use in MIL-H-5606 fluid at operating temperatures ranging from -65° to 160°F. When aircraft designs raised the operating temperatures, newer compounds were developed under MS

specifications with an operating range of -65° to 275°F. These newer compounds are used to manufacture the MS28775 and MS28778 O-ring seals (packings). The MS28775 O-ring replaces AN6227 and AN6230, and MS28778 replaces AN6290; however, O-ring replacement should only be accomplished by part number as specified in the technical manual. (See Figure 3-5.)

NUMBER	NAME	APPLICATION	SYSTEM	REMARKS
	O-RING			
AN6227	Packing, O-ring	Static and dynamic	Hydraulic Pneudraulic	General use -65°F to +160°F
AN6230	Gasket, O-ring	Static only	Hydraulic Pneudraulic	General use -65°F to +160°F
MS28775	Packing, O-ring	Static and dynamic	Hydraulic (MIL-H-5606) Pneudraulic	General use -65°F to +275°F
	O-RINGS FOR FLARED TUBE FITTINGS			
MS28778	Packing, flared tube	Flared tube bosses	Hydraulic Pneudraulic	Replaces AN6290
	NONEXTRUSION RINGS			
MS9058	Ring	Teflon backup for use with MS28778 O-ring gaskets in flared tube bosses	All	Replaces AN6291
MS28774	Retainer, single turn	Teflon backup for use with AN6227, AN 6230, MS28775	All	—
MS28782	Retainer, double turn	Teflon backup for use with AN6227 and MS28775	All	In process of replacing AN6246
MS28783	Ring, double turn	Teflon backup for use with AN6230 and MS28775	All	Replaces AN6244

42-1526

Figure 3-5. Application of O-ring seals and backup rings.

STORAGE

Packings and gaskets should be stored in a dark, cool, dry place; they should be kept away from excessive heat, strong air currents, dampness, and dirt. Do not expose them to electric motors or other equipment that gives off heat and ozone.

O-RINGS

Identification. O-rings are manufactured according to military specifications. They are identified from the technical information printed on the O-ring package. Because the size of O-rings cannot be positively identified visually without the use of special equipment, O-rings are packaged in individual sealed envelopes labeled with all the necessary data. Colored dots, dashes, and stripes, or combinations of dots and dashes on the surface of the O-ring are no longer used to identify O-rings. The part number of a standard O-ring seal is illustrated at Figure 3-6.

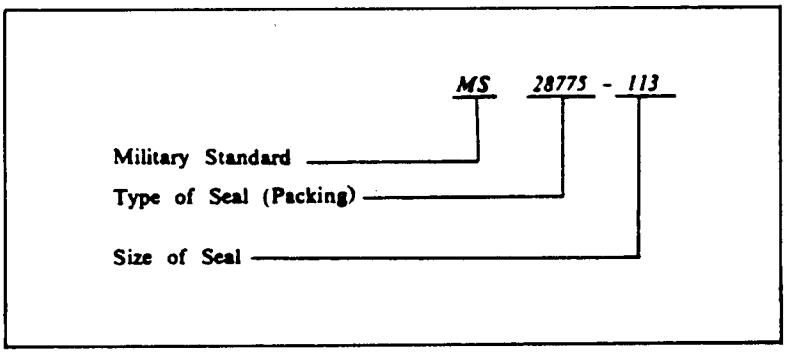


Figure 3-6. Part number of standard O-ring seal.

KZ5330-833-7491
PACKING PREFORMED SYNTHETIC RUBBER
1 EACH (MS28778-5)
DISC-38329
A-5/80
SR 810-B-90
MFD DATE 4-80; CURE DATE 2Q80
STILLMAN RUBBER CO.(MFGR/CONTR)
MIL-G-5510A

Figure 3-7. Manufacturer's cure date.

If the seal's part number cannot be found in the technical order, its size may help determine the part number. The size of an O-ring seal may be determined by measuring the seal's width (W), the inside diameter (ID), or the outside diameter (OD). Figure 3-7 illustrates the various dimensions that can be measured. If two are known, the third can easily be determined. For example, the outside diameter can be found if the width and inside diameter are known. Twice the width plus the inside diameter will equal the outside diameter. Once the measurements of the seal are known, cross-reference it in the supply catalogs.

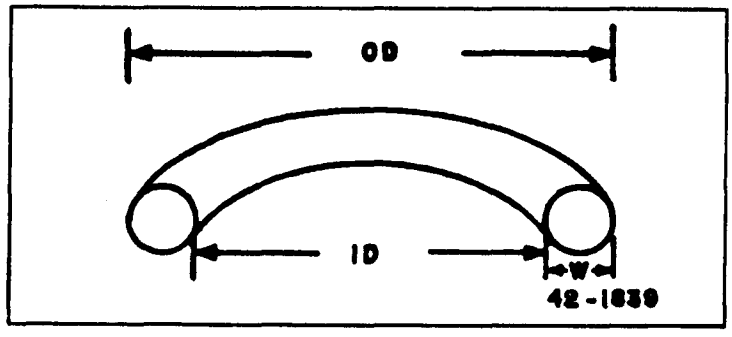


Figure 3-8. Seal dimensions.

Replacement Schedules. Packings, gaskets, and O-rings used in Army aircraft have idefinite shelf life. (See TM 55-1500-204-25/1 for further guidance.)

Removal. Some seals may be removed by squeezing the seal between the thumb and forefinger; this will force the O-ring out of the groove. Then the entire seal is removed. Seals may also be removed with a tool; however, you must carefully choose the correct tool. A variety of tools may be used on any given job, but they should be made from soft metal such as brass and aluminum. Also, tools made from phenolic rod, plastics, and wood may be used. Avoid using pointed or sharp-edged tools that might scratch or mar surfaces or damage the O-rings.

Internal O-Rings. Two acceptable removal methods are as follows:

1. As shown in Figure 3-9, position the hook-type removal tool under the O-ring. Then lift it to allow the extractor tool and the removal tool to pull the O-ring from its place.

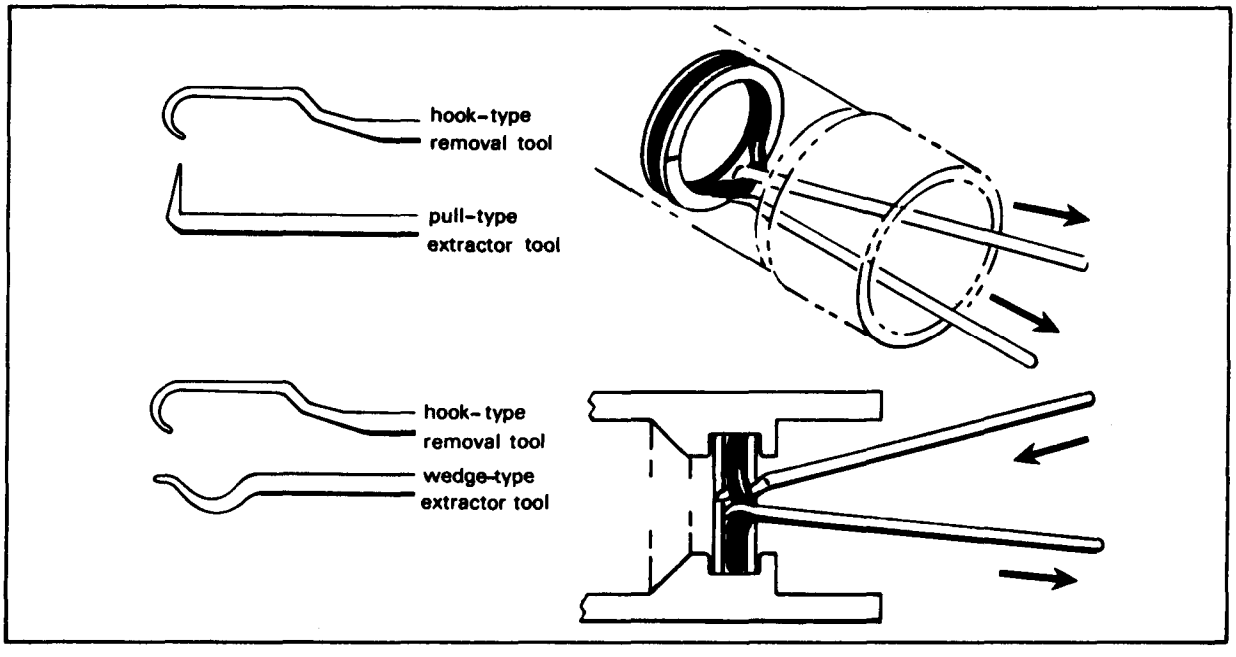


Figure 3-9. Pull method (single internal O-ring).

The pull method may be used to remove dual O-rings. (See Figure 3-10.) Position the extractor tool under both O-rings, and use the hook-type removal tool to extract both O-rings with little effort.

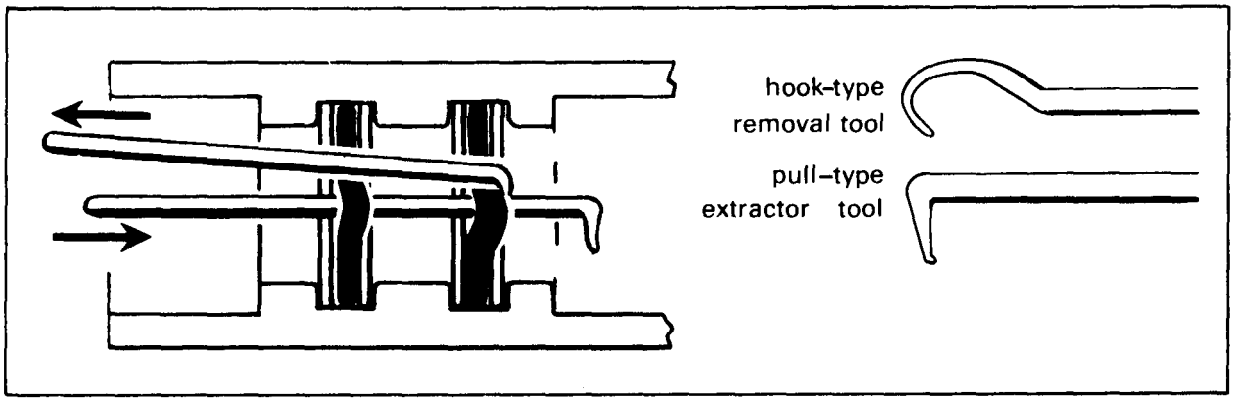


Figure 3-10. Pull method (dual internal O-rings).

2. There is a similar method to remove internal O-rings. Use the extractor tool to push, rather than pull, the O-ring from its place. (See Figure 3-11.)

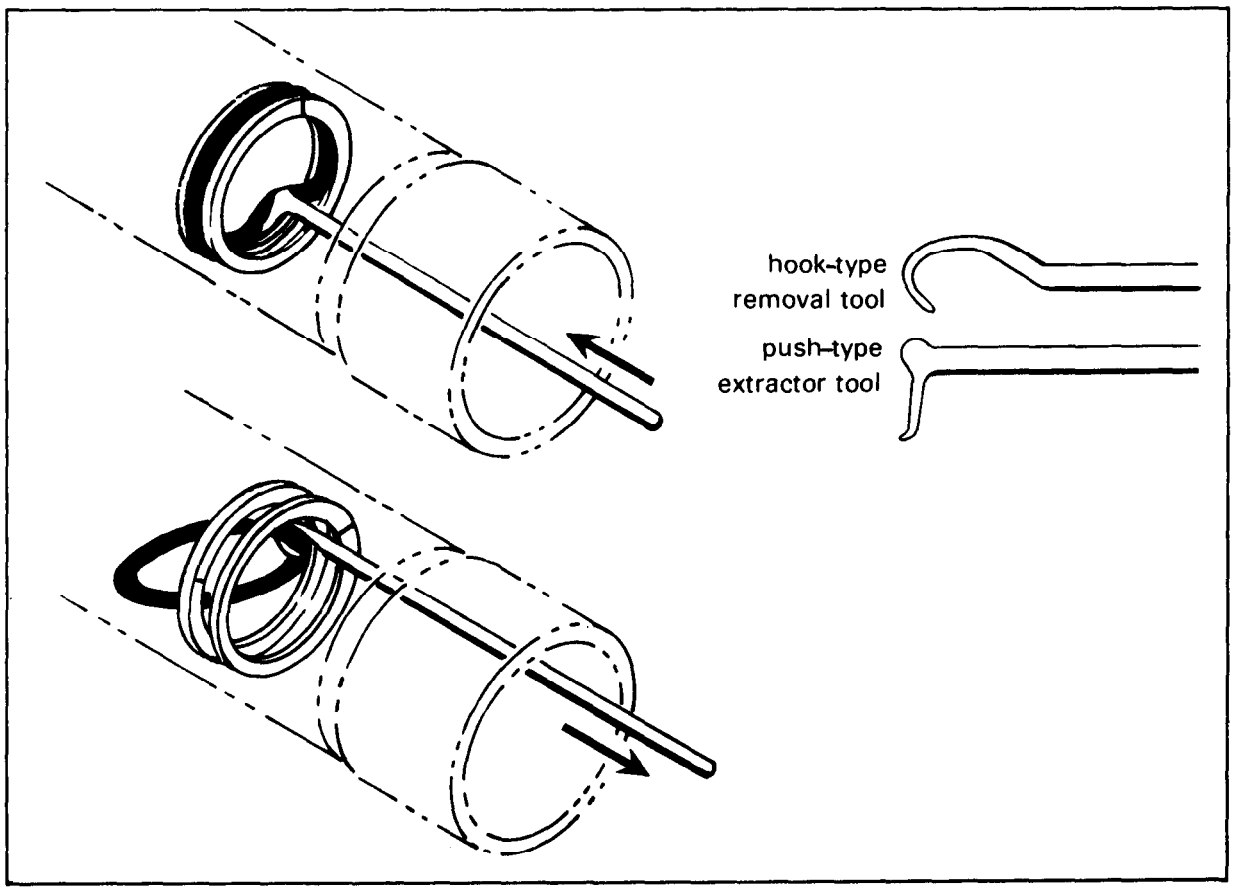
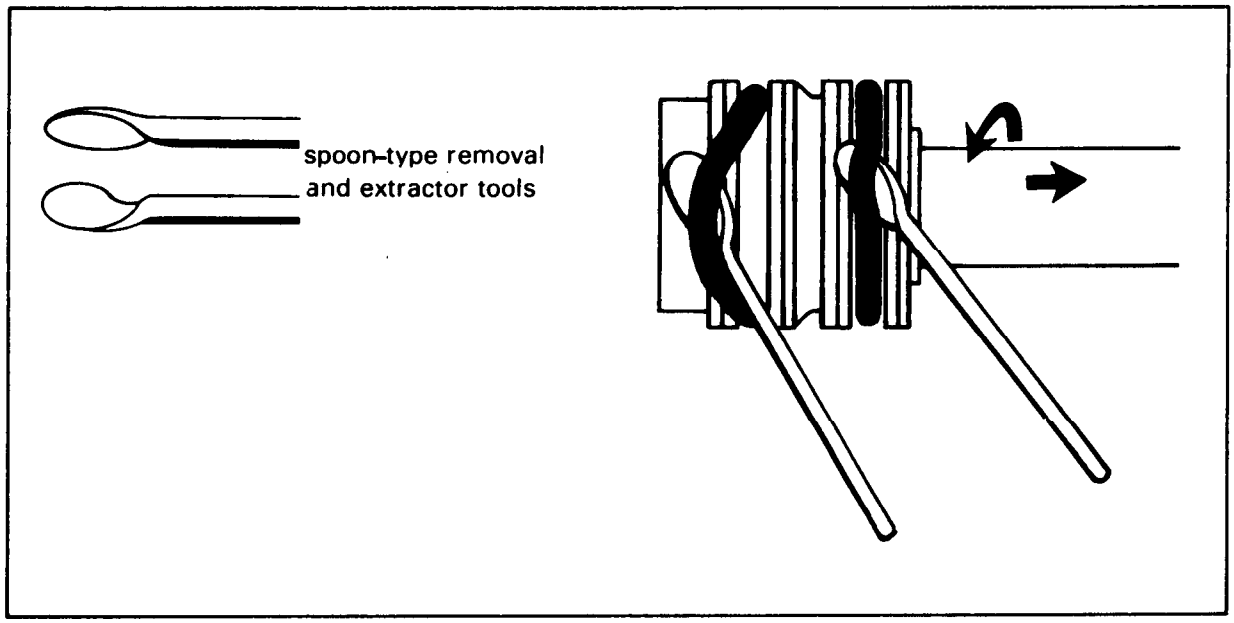


Figure 3-11. Push method (internal O-rings).

External O-Rings. It is easier to remove external O-rings than internal ones. Two acceptable removal methods are as follows:

1. Position a spoon-type extractor under the seal. After taking the O-ring from its cavity, hold the spoon still, and rotate and withdraw the piston. (See Figure 3-12.)



2. Insert a wedge-type extractor tool under an O-ring, and use the hook-type removal tool to hook the O-ring. Pull slightly on the hook to remove the O-ring from its cavity. (See Figure 3-13.)

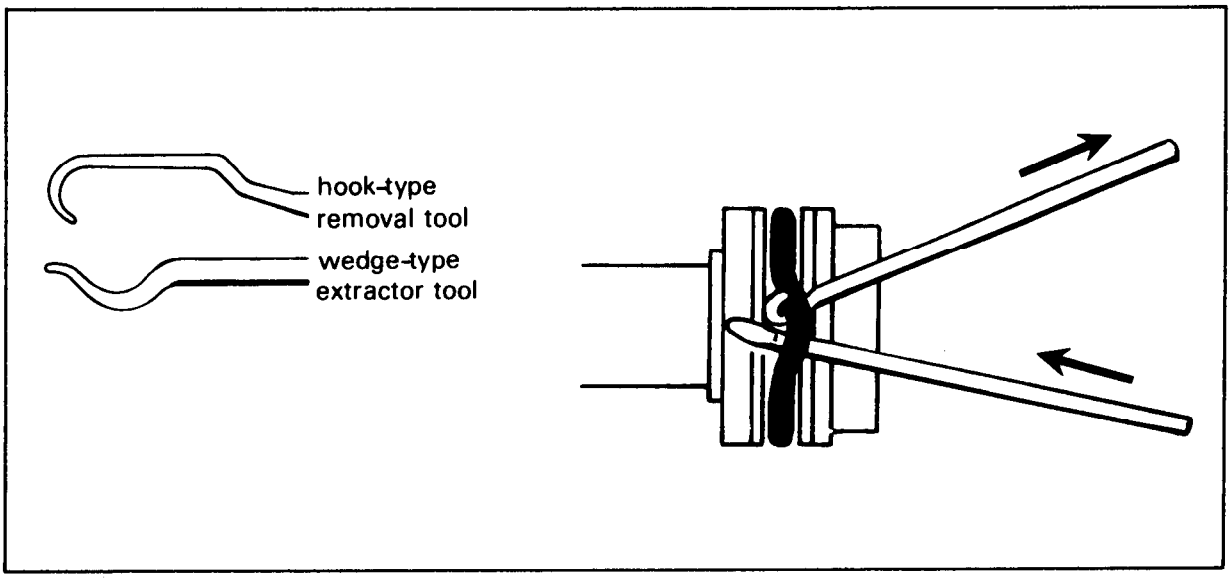


Figure 3-13. Pull method (external O-rings).

Inspection. After removing all O-rings, thoroughly clean the parts that will receive new O-rings. Remove each replacement O-ring from its sealed package and inspect it for defects, such as blemishes, abrasions, cuts, or punctures. Although the outer surface of an O-ring may appear perfect at first glance, surface flaws may exist. These flaws can prevent satisfactory O-ring performance under the variable operating pressures of aircraft systems. Reject O-rings with flaws.

Also check the inner surface for small cracks, particles of foreign material, and other defects that might cause leakage or shorten the life of the ring by rolling the ring on an inspection cone or dowel. The slight stretching of the ring when it is rolled inside out will help to reveal some defects not otherwise visible. Check each O-ring further by stretching it between the fingers, but take care not to exceed the elastic limits of the rubber.

Installation. Before installing the O-ring, ensure that the area where it is to be installed is clean and free from all contamination. Then immerse the O-ring in clean hydraulic fluid. A hydraulic system cannot operate successfully if hydraulic seals are not handled and installed properly. These seals are comparatively soft and should not be nicked, scratched, or dented. They should be kept free of dirt and foreign matter and should not be exposed to extreme weather conditions. Hydraulic seals should not be picked up with sharp instruments, and the preservative should not be removed until they are ready for installation.

Generally the O-ring seal requires no adjustment when it is installed; however, you must observe a few precautions during installation, or early failure will result. First, check to see that the seal is the right size. The applicable technical manual will specify what special lubricant should be applied. When installing the seal, use extreme care to prevent scratching or cutting it on threads or sharp corners.

During installation, avoid rolling and twisting the O-ring to put it into place. If possible, keep the position of the O-ring's mold line constant. Use protective measures such as the O-ring entering sleeves (soft, thin-walled, metallic sleeves illustrated in Figure 3-14) when installation requires spanning or inserting the O-ring through sharp, threaded areas, ridges, slots, and edges which may damage the O-ring. If the recommended O-ring entering sleeve is not available, make paper sleeves and covers by using the seal package (gloss side out) or lint-free bond paper. (See Figure 3-15.)

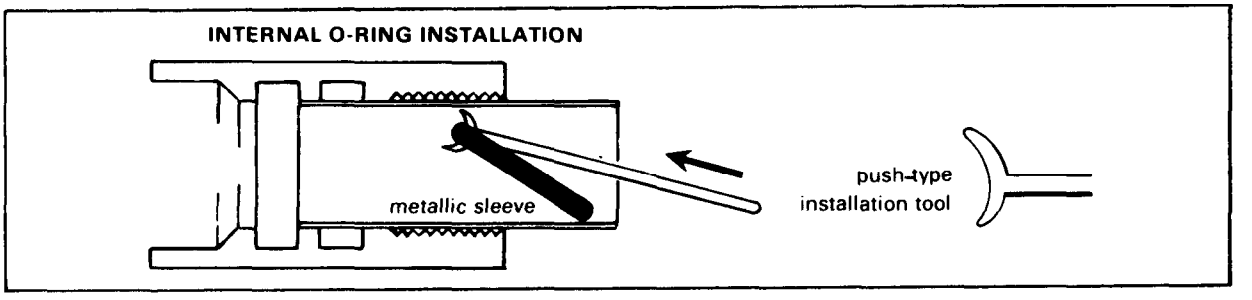
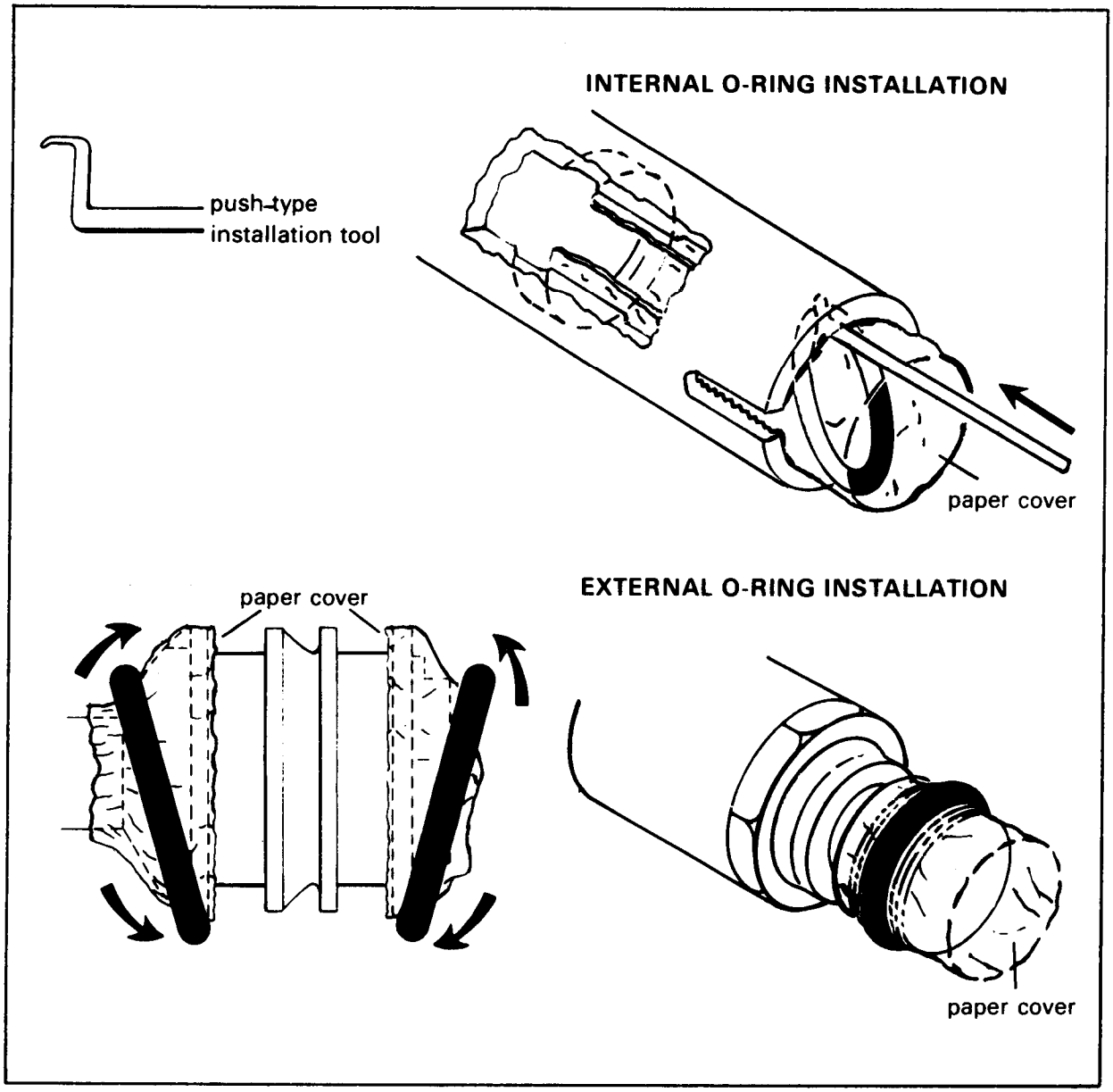


Figure 3-14. O-ring entering sleeves.



Never use adhesive tapes to cover danger areas on components. Gummy substances left by the adhesives are extremely detrimental to hydraulic systems. After the O-ring is placed in the provided cavity, gently roll the O-ring with the fingers to remove any twist that might have occurred during installation. Twists in the O-ring will prevent it from functioning properly.

Storage. Proper storage practices must be observed to protect O-rings. Most synthetic rubbers are not damaged by several years of storage under ideal conditions; however, their enemies are heat, light, moisture, oil, grease, fuels, solvents, thinners, strong drafts, or ozone (form of oxygen formed from an electrical charge). Damage by exposure is magnified when

rubber is under tension, compression, or stress. When storing O-rings, avoid the following conditions:

- Stacking parts improperly and storing them in improper containers, which can cause defects in shape.
- Applying force to the O-ring corners and edges and squeezing rings between boxes and storage containers, which can cause creases.
- Storing rings under heavy parts, which can cause compression and flattening.
- Using staples to attach identification, which can cause punctures.
- Hanging U-rings from nails or pegs which can cause the rings to become dirty and develop defective shapes (O-rings should be kept in their original envelopes).
- Allowing rings to become oily or dirty because of fluids leaking from parts stored above and adjacent to O-ring surfaces.
- Applying adhesive tape directly to O-ring surfaces (a torn O-ring package should be secured with pressure-sensitive, moisture-proof tape, but the tape must not contact the O-ring surface).
- Keeping overage parts because of improper storage arrangements or unreadable identification (O-rings should be arranged so that older seals are used first).

BACKUP RINGS

Types. Backup rings support O-rings and prevent them from wearing and causing leakage. The two types of backup rings are the teflon type and the leather type. Teflon backup rings are generally used with packings and gaskets; however, leather backup rings may be used with gasket-type seals in systems operating up to 1,500 psi. Teflon rings are made from a fluorocarbon-resin material which is tough, friction-resistant, and more durable than leather. Teflon backup rings do not deteriorate with age, can tolerate temperatures greater than those encountered in high-pressure hydraulic systems, and are unaffected by any other system fluid or vapor.

Identification. Backup rings are not color-coded or marked and must be identified from package labels. The dash number which follows the specification number on the package shows the size and, in some cases, relates directly to the dash number of the O-ring for which the backup ring is dimensionally suited. For example, the single spiral teflon ring MS28774-6 is used with the MS28775-006 O-ring, and the double spiral teflon ring MS28782-1 is used with the AN6227B-1 O-ring.

Installation. Care must be taken when handling and installing backup rings. They should be put on by hand without using sharp tools.

Teflon Backup Rings. Teflon backup rings must be inspected before reuse and must be discarded if they have compression damage, scratches, cuts, nicks, or fraying conditions. Before installing a teflon spiral ring in an internal groove, stretch it slightly. (See Figure 3-16.) While the teflon ring is being put in the groove, turn the component in a clockwise direction. (See Figure 3-17.) This will expand the ring diameter and reduce the possibility of damaging the ring.

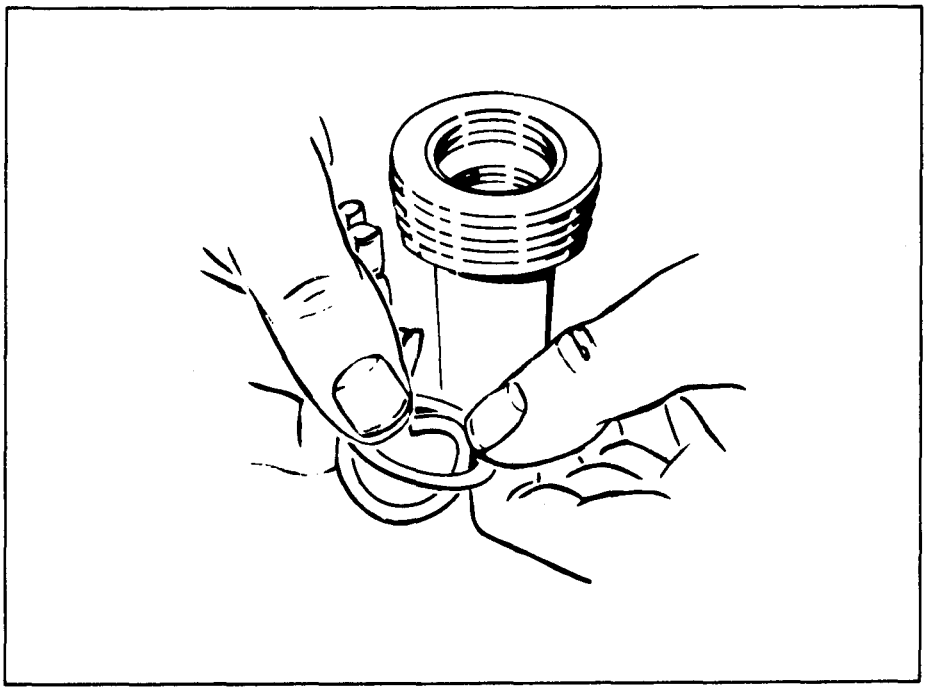


Figure 3-16. Teflon spiral ring being stretched.

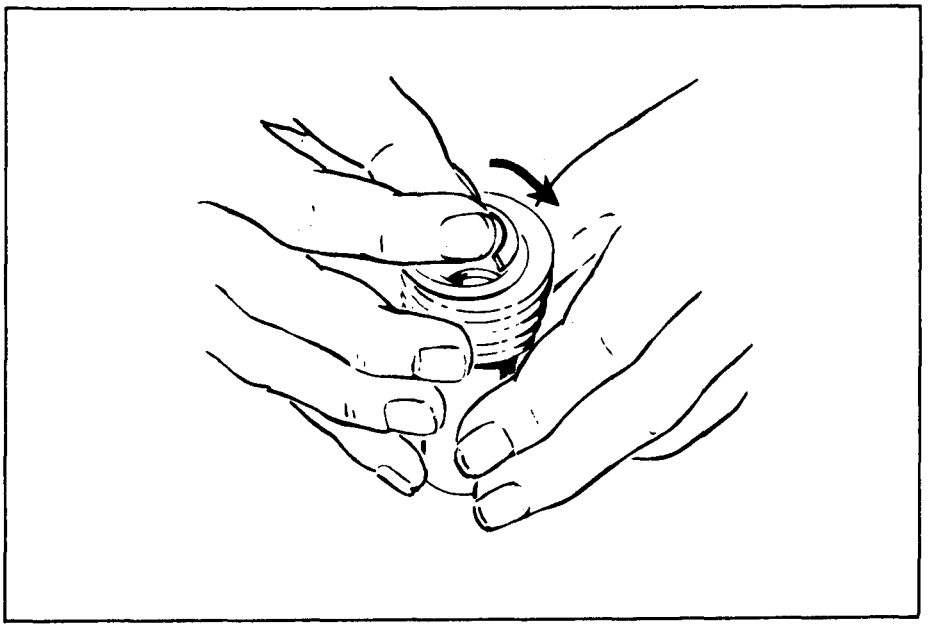


Figure 3-17. Component being turned in a clockwise direction.

Before installing a teflon spiral ring in an external groove, change the ring's right-hand spiral to a left-hand one. (See Figure 3-18.) As the ring is put into the groove, turn the component in a clockwise direction. This will contract the ring diameter and reduce the possibility of damaging the ring.

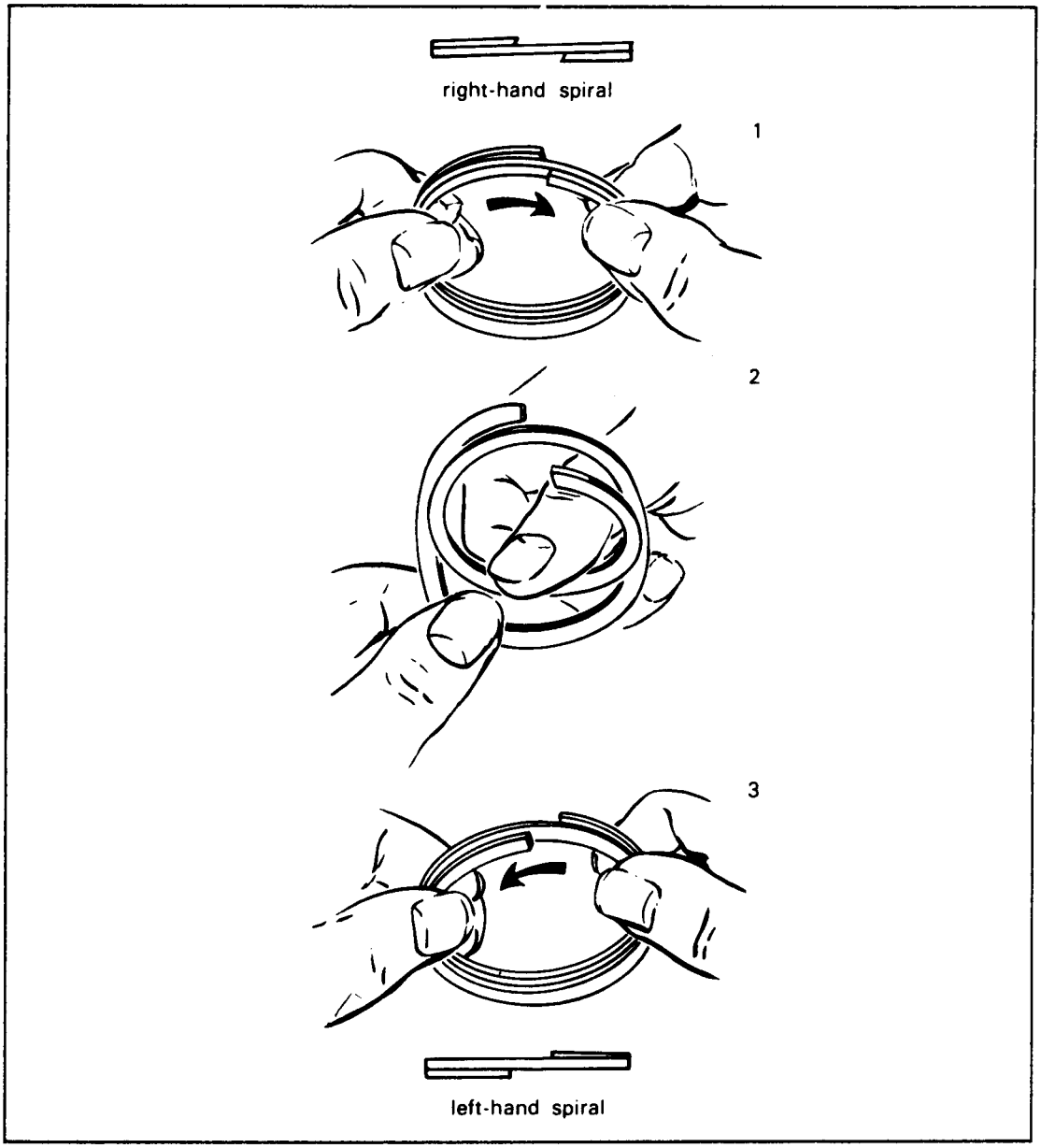


Figure 3-18. Ring's right-hand spiral changed to a left-hand spiral.

Backup rings may be installed individually if pressure acts on only one side of the seal. (See Figure 3-19.) In this case, install the backup ring next to the O-ring and opposite the pressure force. Figure 3-20 illustrates the correct way to install single and dual backup rings. When dual backup rings are installed, the split scarfed ends must be staggered, as shown in Figure 3-21.

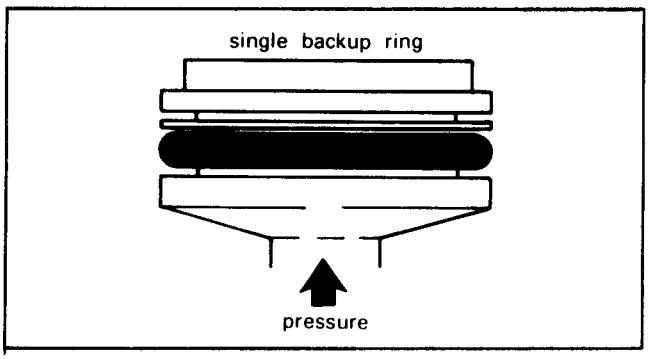


Figure 3-19. Single backup ring.

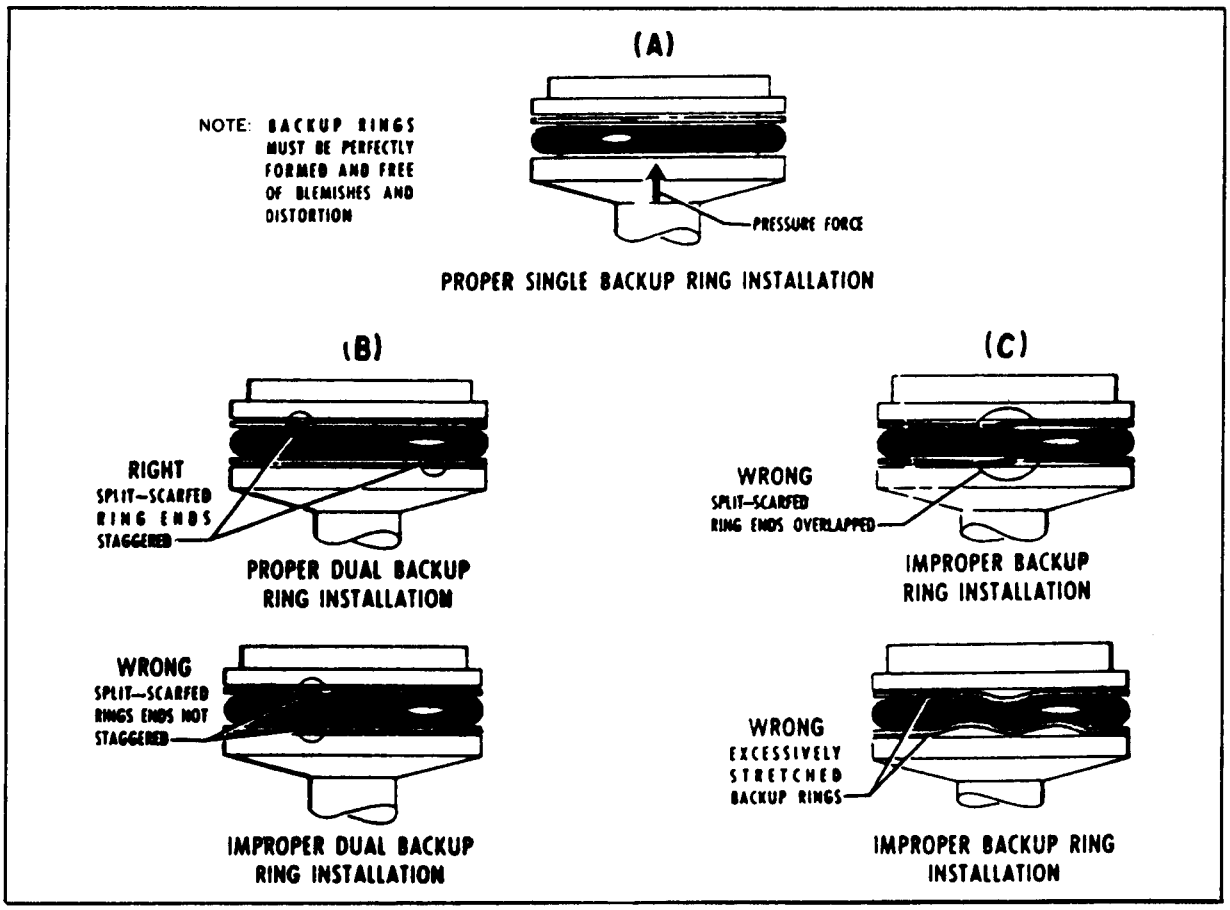


Figure 3-20. Single and dual backup ring installation.

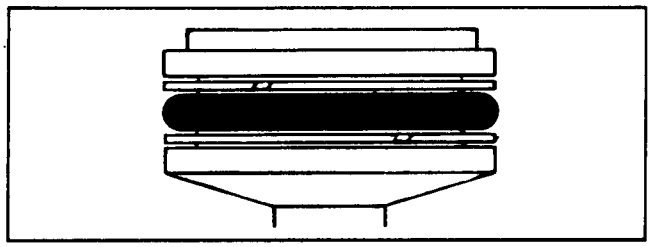


Figure 3-21. Dual (double) backup ring.

Leather Backup Rings. Leather backup rings must be inspected for defects before reuse. Defective rings must be discarded. Figure 3-22 shows a leather backup ring properly-installed.

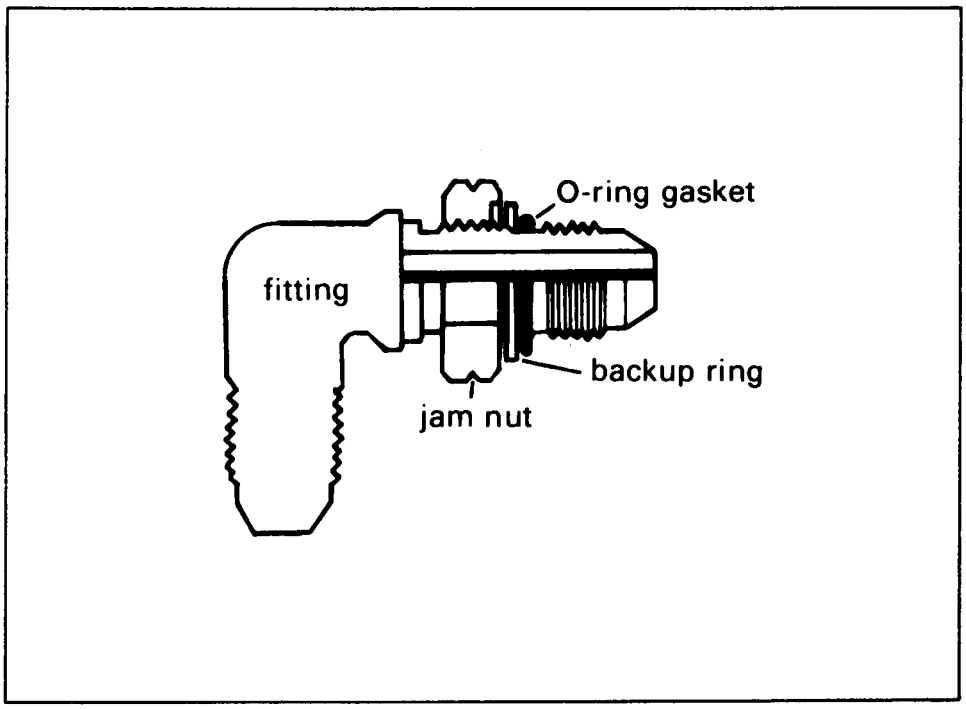


Figure 3-22. Leather backup ring installed.

To install a leather backup ring--

- Soak the new backup ring in clean hydraulic fluid until it is flexible enough for good installation.
- Soak the new gasket in the same type of hydraulic fluid used in the hydraulic system.
- Examine the fitting groove for roughness that might damage the seal.
- Position the jam nut above the fitting groove, and coat the male threads of the fitting sparingly with hydraulic fluid.
- Place the backup ring in the fitting groove with the smooth side away from the jam nut; then work it into the counterbore of the jam nut.
- Install the gasket in the fitting groove against the backup ring.
- Turn the jam nut down until the packing is pushed firmly against the threaded portion of the fitting.
- Install the fitting into the boss; turn it until the packing has contacted the boss (the jam nut must turn with the fitting). (See Figure 3-23.)

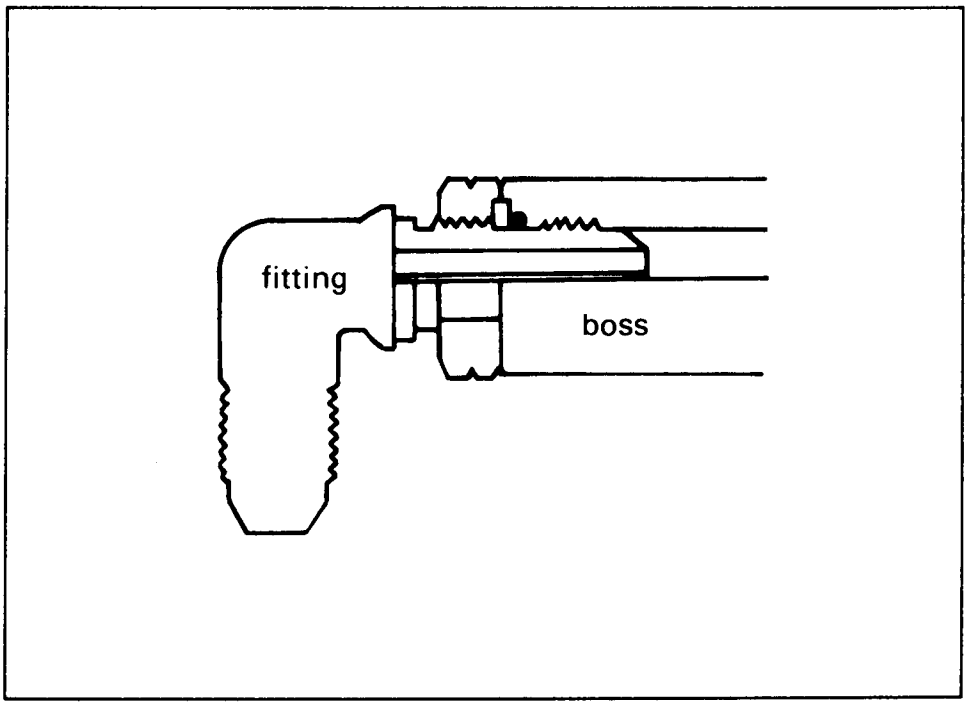


Figure 3-23. Fitting installed.

- While holding the jam nut to prevent it from turning, turn the fitting one and one-half additional turns.
- Position the fitting by turning it not more than one turn.
- Hold the fitting in the desired position, and turn the nut down tight against the boss.

Storage. Precautions similar to those for O-rings must be taken to prevent contamination of backup rings and damage to hydraulic components.

Teflon backup rings may be stocked in individual sealed packages like the O-rings, or several may be stored on a cardboard mandrel. If unpackaged rings are stored for a long time without using mandrels, an overlap may develop. To prevent this condition, stack teflon rings on a mandrel of a diameter comparable to the desired diameter of the spiral ring. Stack and clamp the rings with their coils flat and parallel.

Do not store leather backup rings on mandrels as this can possibly stretch and distort the original shape of the leather ring. Leather rings should be stored in sealed individual packets.

SHAFT SEALS

Most shaft seals on pumps have two flat surfaces that rotate against each other. One flat. surface is made from a soft material such as bronze or carbon and is called the sealing ring. The other flat surface is made

from stainless steel and is called the mating ring. (See Figure 3-24.) The mating ring rotates with the drive shaft. Although all makes of shaft seals differ in design, they perform the same function; they seal a moving part--the shaft. The shaft seal must limit the leakage of fluid trying to escape, but not stop it altogether. This is because the shaft seal acts like a bearing and must be lubricated like one. The lubricant comes from the slight leakage of fluid past the two mating surfaces. In Figure 3-24, notice that the sealing ring can move back and forth on the drive shaft. The O-ring seal will prevent leakage around the seal, while the spring forces the mating ring against the sealing ring. The spring compensates for the wear of the sealing ring by forcing the mating ring against the sealing ring. It also ensures a positive seal when the shaft is not rotating. Never scratch or damage the two mating surfaces because this will cause them to leak.

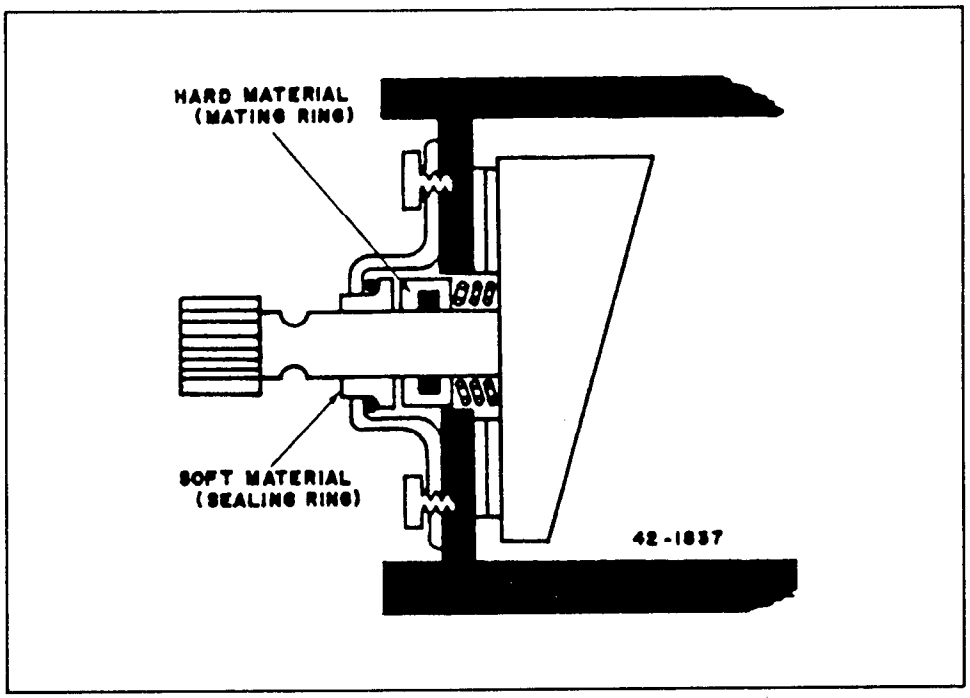


Figure 3-24. Pump shaft seal.

QUICK-DISCONNECT COUPLINGS

Quick-disconnect couplings of the self-sealing type are used at various points in all hydraulic systems. These couplings are installed at locations where frequent uncoupling of lines is required for inspection and maintenance. Each coupling assembly consists of two halves held together by a union nut. Each half contains a valve which is held open when the coupling is connected; this allows fluid to flow in either direction through the coupling. When the coupling is disconnected, a spring in each half closes the valve. This prevents loss of fluid and entrance of air. The union nut has a quick-lead thread which allows the coupling to be connected or disconnected by turning the nut. Various types of union nuts are used in hydraulic systems. For one type, a quarter turn of the union

nut locks or unlocks the coupling. For another type, a full turn is required. Some couplings require wrench tightening; others are connected and disconnected by hand. Some installations require that the coupling be secured with safety wire; others do not require any form of safetying. Because of these differences, all quick-disconnect couplings must be installed according to the instructions in the applicable maintenance manual.

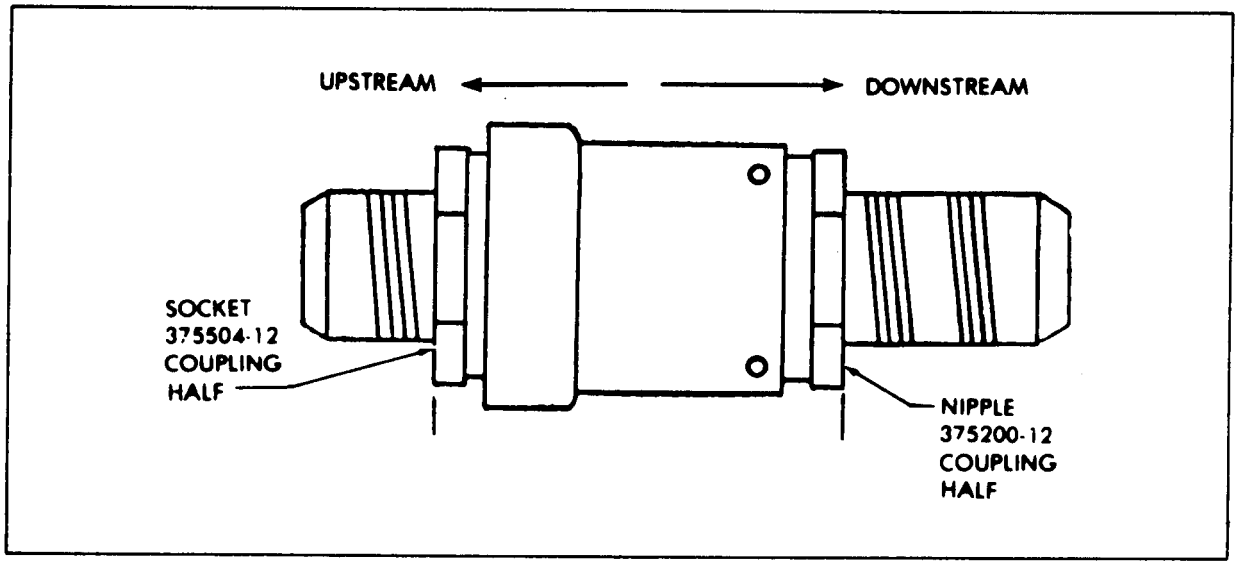


Figure 3-25. Typical quick-disconnect coupling.